

# **Effectiveness of Competitive Prototyping and Preliminary Design Review**

## **Prior to Milestone B**

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# Cyclic Use of Prototyping

- Pre - WW II



- “Fly-Before-Buy”



- Packard Commission

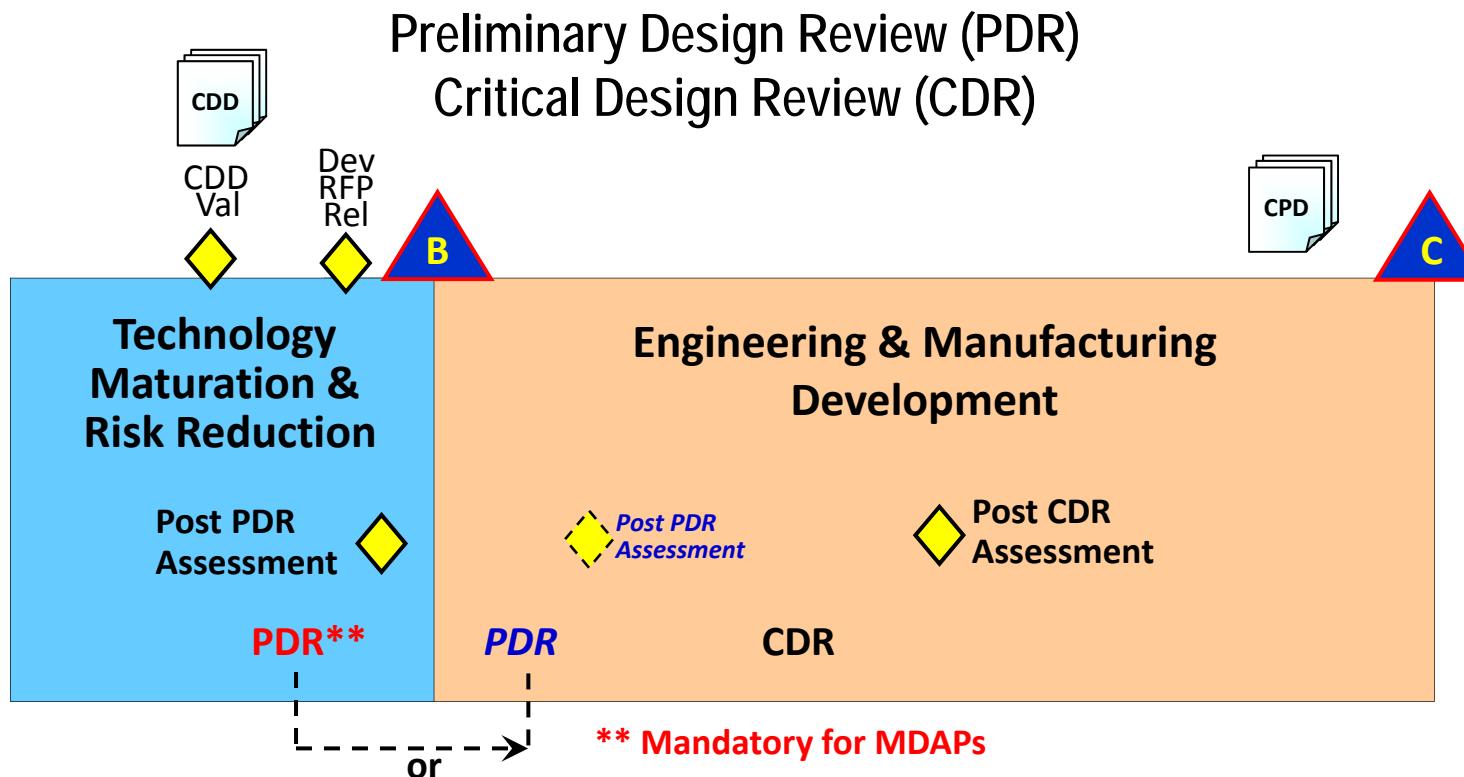


# Weapons System Acquisition Reform Act of 2009 and Prototyping

- Competitive prototyping of systems or critical subsystems before Milestone B approval
- If competitive prototyping is waived by MDA, a prototype must still be produced before MS B



# Defense Acquisition Management System 2013



PDR Before Milestone B	PDR After Milestone B
<ul style="list-style-type: none"><li>•Planned for in Acquisition Strategy</li><li>•PDR Report provided to MDA at MS B</li><li>•Includes recommended requirements trades resulting from prototyping and critical technology demonstrations</li><li>•Mandatory for MDAPs and DASD(SE) participates</li></ul>	<ul style="list-style-type: none"><li>•Planned for in Acquisition Strategy</li><li>•PDR Report provided to MDA prior to Post PDR Assessment</li><li>•Reflects requirements trades</li><li>•At Post PDR Assessment, MDA considers PDR report; determines action(s) required to achieve APB objectives and issues ADM</li></ul>

# Technology and Manufacturing Readiness Levels



TRL 1-3 Analytical Experimental Critical Function/ Characteristic Proof of Concept	TRL 4 Component and/or Breadboard Validation in a Laboratory Environment	TRL 5 Compon- ent and/or Bread- board Validation In a Relevant Environ- ment	TRL 6 System/ Sub- system Model or Prototype Demonstrated In a Relevant Environ- ment	TRL 7 System Prototype Demonstrated In an Operational Environment	TRL 8 Actual System Com- pleted Qualified Through Test and Demon- stration	TRL 9 Actual System “Mission Proven” Through Success- ful Oper- ations	Technology Readiness Levels  Defense Acquisition Guidebook para. 10.5.2
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Section 2366b of Title 10, United States Code, requires certification that the technology in the program has been “demonstrated in a relevant environment” prior to Milestone B. (This is interpreted as TRL 6.)

# Joint Lightweight Tactical Vehicle (JLTV)



**USA / USMC**

**Contract Type**

**TD Contract Costs**

**Requirements**

**TMRR Phase**

**Prelim Design Rev**

**TRL (at MS B)**

**BAE Systems**

Various

\$62.9 M

**AM General/GDLS**

Various

\$61.3 M

CDD, 15 March 2012

27 months

June - July 2009

**Lockheed Martin**

CPFF

\$53.4 M

# Littoral Combat Ship (LCS)



**USN**

**Contract Type**

**TD Contract Costs**

**Requirements**

**TMRR Phase**

**Preliminary Design Review**

**TRL (at MS B)**

**General Dynamics**

FPI

\$575 M

validated CDD, June 2008; 10 KPPs

72 months

July 2003 (prior to MS A)

? (integration w/mission packages) / 9 (seaframe)

**Lockheed Martin**

FPI

\$537 M

# Small Diameter Bomb (SDB) II



**USAF / USN**

**Contract Type**

**TD Contract Costs**

**Requirements**

**TMRR Phase**

**Critical Design Rev**

**TRL (at MS B)**

**Boeing / Lockheed**

**CPFF**

**\$161.4 M**

**validated CDD, June 2009; 5 KPPs**

**42 months**

**within 6 months of MS B (June 2010)**

**6 (Program Office Estimates)**

**Raytheon**

**CPFF**

**\$161.4 M**

# **Research Issue**

Determine if DoD Instruction 5000.02 policies for Major Defense Acquisition Programs (MDAPs) relating to competitive prototyping, technology readiness, and Preliminary Design Review (PDR) prior to Milestone (MS) B are having the desired effect on program outcomes.

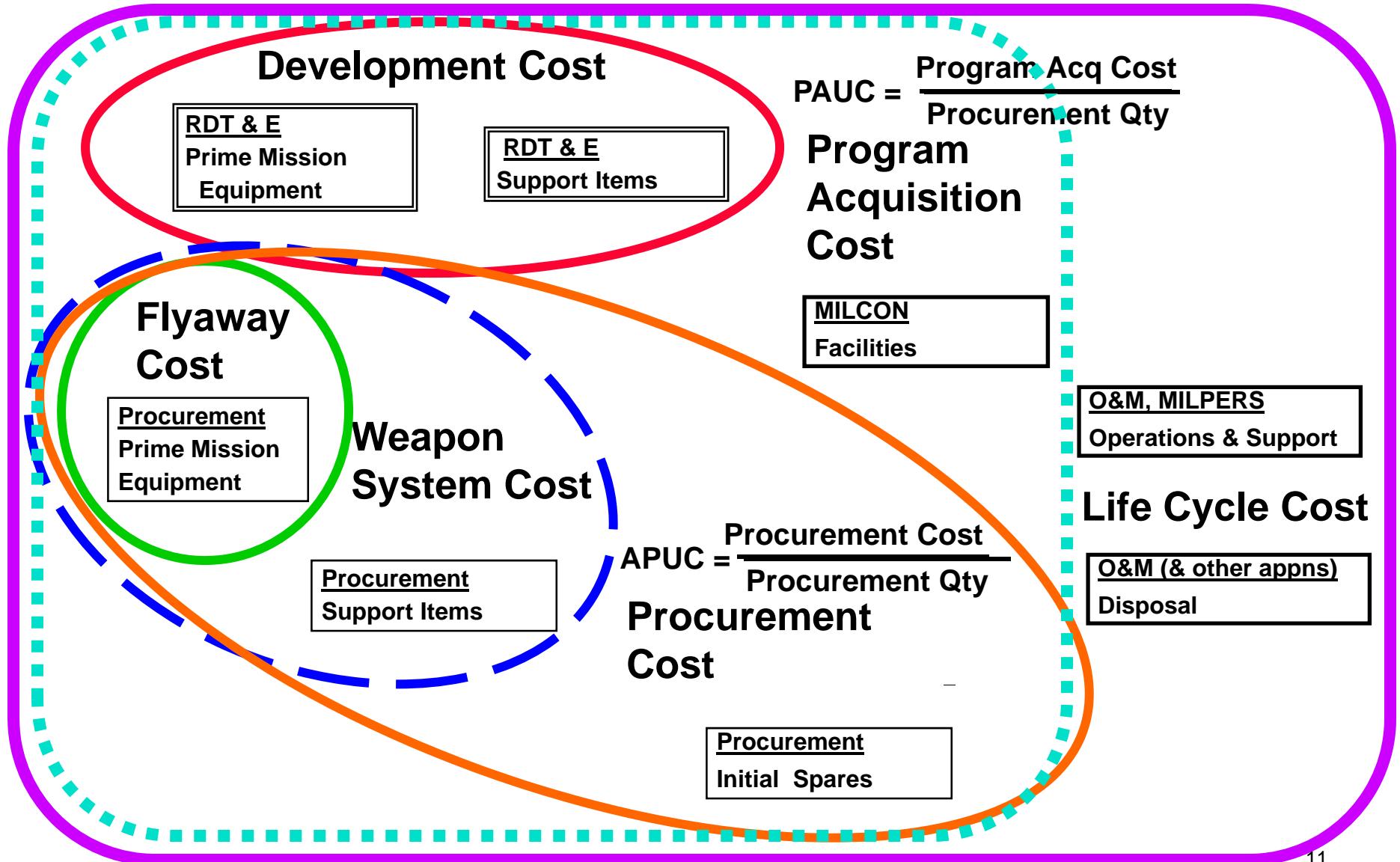
## **Research questions:**

1. Does the knowledge from competitive prototyping and a PDR conducted prior to MS B result in better decisions relative to requirements, design, and resources?
2. What are the effects of the competitive prototyping, technology readiness, and PDR policies on program costs and program schedules?

# Research Methodology

- Cost growth was determined by comparing the original Program Acquisition Unit Cost (PAUC) with the current PAUC estimate, calculated to the same base-year dollars, as reported in the Unit Cost Report (UCR) of the annual Selected Acquisition Reports (SARs) for 2011 and 2012
- Annual SARs also identify if programs have suffered an Acquisition Program Baseline (APB) threshold schedule breach
- Government Accountability Office (GAO) survey data was used to identify programs that have demonstrated technology maturity on prototypes in a relevant environment (Technology Readiness Level 6) and have conducted a preliminary design review prior to Milestone B

# Life Cycle Cost Composition



# Research Methodology

- Descriptive statistics are used to analyze cost growth (percent change to date in PAUC) and schedule breaches for the MDAPs that have conducted competitive prototyping and PDR activities.
- Similar descriptive statistics are used to analyze the balance of the MDAPs included in a particular annual SAR submission.
- The percentage of programs that have negative cost growth (negative percent change to date in PAUC) from each population is compared. The population with the highest number of negative cost growth programs is preferred.
- The percentage of programs that suffered an APB schedule threshold breach from each population is compared. The population with the lowest percent of schedule breaches is preferred.

## Research Results

*PAUC Cost Growth Results.* Based upon data from the 2011 and 2012 SAR, programs that demonstrated technology maturity on prototypes in a relevant environment (TRL 6) and conducted a preliminary design review prior to Milestone B *were more often to show negative PAUC cost growth.*

This result was seen in all DoD Components.

# Research Results

Table 2. Programs Costing Less, Selected Acquisition Report, December 31, 2011

Component	Programs w/Prototypes & PDR			Balance of Programs		
	Programs Costing Less	Total Programs	Percent	Programs Costing Less	Total Programs	Percent
Army	6	7	86	3	12	25
Navy	7	15	47	6	20	30
Air Force	5	10	50	4	15	27
Def Agency	1	1	100	2	9	22
<b>Total</b>	<b>19</b>	<b>33</b>	<b>57</b>	<b>15</b>	<b>56</b>	<b>27</b>

Table 3. Programs Costing Less, Selected Acquisition Report, December 31, 2012

Component	Programs w/Prototypes & PDR			Balance of Programs		
	Programs Costing Less	Total Programs	Percent	Programs Costing Less	Total Programs	Percent
Army	5	8	62	4	12	33
Navy	8	18	44	4	20	20
Air Force	3	8	38	6	17	35
Def Agency	0	0	0	4	5	80
<b>Total</b>	<b>16</b>	<b>34</b>	<b>47</b>	<b>18</b>	<b>54</b>	<b>33</b>

# Research Results

Schedule Threshold Breach Results. Based upon data from the 2011 and 2012 SAR, programs that demonstrated technology maturity on prototypes in a relevant environment (TRL 6) and conducted a preliminary design review prior to Milestone B did not suffer fewer APB schedule threshold breaches.

This result was seen in all DoD Components except the Air Force.

# Research Results

Table 4. Program Schedule Breach, Selected Acquisition Report, December 31, 2011

Component	Programs w/Prototypes & PDR			Balance of Programs		
	Programs w/Schedule Breach	Total Programs	Percent	Programs w/Schedule Breach	Total Programs	Percent
Army	2	7	28	2	12	17
Navy	4	15	27	5	20	25
Air Force	4	10	40	6	15	40
Def Agency	1	1	100	4	9	44
<b>Total</b>	<b>11</b>	<b>33</b>	<b>33</b>	<b>17</b>	<b>56</b>	<b>30</b>

Table 5. Program Schedule Breach, Selected Acquisition Report, December 31, 2012

Component	Programs w/Prototypes & PDR			Balance of Programs		
	Programs w/Schedule Breach	Total Programs	Percent	Programs w/Schedule Breach	Total Programs	Percent
Army	3	8	38	4	12	33
Navy	6	18	33	3	20	15
Air Force	2	8	25	7	17	41
Def Agency	0	0	0	0	5	0
<b>Total</b>	<b>11</b>	<b>34</b>	<b>30</b>	<b>14</b>	<b>54</b>	<b>26</b>

# Future Research

- To remove some of the uncertainty in the cost growth metric, compare PAUC based upon the original cost estimate with actual PAUC. Actual PAUC can be determined from contracts found in the Defense Cost and Resource Center (DCARC) database.
- To remove some of the uncertainty in the schedule slippage metric, compare the original schedule estimate with actual schedule performance data. Actual schedule performance data for this comparison should be available in the DCARC database or Defense Acquisition Management Information Retrieval (DAMIR).
- Finally, the challenge in using cost growth and schedule slippage metrics is to tie them back to the use of competitive prototyping (to reveal technology readiness) and the use of an early PDR. The knowledge from these activities and how that knowledge is applied will tell us whether these policies have had an effect. To that end, more detailed surveys, such as those conducted annually on selected weapon systems by the GAO, will aid in helping establish the cause-effect relationship between policy and program outcomes.